Stun Gun Self Defense Ring and Bracelet

ECE (Electrical and Computer Engineering) 4871 Senior Design Project

Section L01, Team Sweet Dreams

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Executive Summary

The world is a dangerous place especially for women as one in five women are sexually assaulted during their time at college [1]. This is a major problem that Sweet Dreams has decided to find a solution to. Sweet Dreams' Self Defense Jewelry is a bracelet and ring combo made to protect the user while looking fashionable and unassuming. The main goal of this product is to be able to protect the user from a variety of dangerous situations. With that goal in mind, Sweet Dream strived to find a solution that no one would suspect to be a weapon, would be hard for the user to lose and be effective in defense. In the end it was agreed upon to create the jewelry set.

The bracelet component would hold must of the electronic components such as the battery, GPS, Bluetooth, heart rate monitor, and circuitry for a stun gun. All of these would be assembled using integrated circuits on a PCB inside the bracelet. The bracelet then connects to the ring through an optic cable. The ring contains electrodes so when the user punches an attacker, it triggers the stun gun circuit in the bracelet which sends the charge through the cable out the electrodes and shocks the attacker on contact. The design will cost $47 to produce.

The design work by whenever the woman feels unsafe, she can press a button on the side of the bracelet which would charge the stun gun circuit and notify her 5 -prechosen contacts that she feels unsafe. Then when she punches an attacker, this will cause the stun gun circuit to discharge shocking the attacker and notifying the police. Also, if the user's heart rate drops below a given threshold (aka she has been knocked out), the product will notify her contacts as well. The design stands apart from competitors as other products either focus on defense or notifying loved one, while Sweet Dreams' product does both. The product will be sold for $100 but the lives it will save is priceless.

1. Introduction

Sweet Dream is a team requesting $301,000 in funding to develop a self-defense ring and bracelet set. Today, it is normal for women to be hyperaware of their surroundings as they navigate through an unpresuming life. It has also become normal for women to buy pepper spray, pocketknife, brass knuckles, etc. To keep themselves safe. However, all these products are hard to use, clanky and obvious to the attacker, and are often not allowed into public events which is a place where tools like this would be necessary. Our product is designed to shock the attacker while being discrete and stylish for the user. The bracelet ring combo will have the main components of the ability to shock the perpetrator, track location of the device through GPS, an, and monitor the heart rate of the user to identify if the user is alive. In addition to the technical requirements, the final product will be discrete, affordable, durable, easy to use, and adjustable for users. The product will consist of a conductive nanocircuit with a Bluetooth network, and power usage and consumption capabilities. There will be an external USB-C port for recharging. The technical challenges that will be faced are the small size that the electronics will have to be to be lightweight for the customer, wearable electronics codes, and standards [2], and the regulations of weapons at events.

The primary desired solution is the one described with the bracelet and ring combo acting as a stun gun. The successful completion of this design will be demonstrated by a successful current discharge from the ring's electrocuted after meeting all the right conditions/triggers. This will be measured by either having a multimeter measure the current discharge or asking for a volunteer to pretend to be the attacker. However, there are many technical obstacles between now and a successful completely of the product therefore, a backup solution would make the ring into a flashlight instead of stun gun. Therefore, the ring will emit a bright light blinding the attacker.

This will be easier to implement as concerns about insulation will become obsolete and no physical contact between the user and attacker will be needed.

The rest of the document will go into more details about the specific design and goals. Then it will become more technical as the technical specification are explained and how they fit in the design. Within the description of the design, the justification, engineering analysis and the codes and standards affecting the project are explored. Then the document takes another shift by focusing more on the logistics such as scheduling, marketing, and cost analysis. The document then wraps up with a quick description of the status of the project and the delegated leadership roles.

2. Project Description, Customer Requirements, and Goals

The subject will be able to monitor the heart rate and GPS location in an accompanying app that will be able to hold emergency contacts that can be contacted in case of use of the weapon.

The requirements for the customers are that the product has/is:

- Concealable
- GPS tracking
- Long battery life
- Low cost
- Comfortable while aesthetically pleasing
- Durable
- User friendly
- And shocks the perpetrator

All the requirements for the customers align with the hopes of the company and steps will be taken to ensure all the requirements are met.

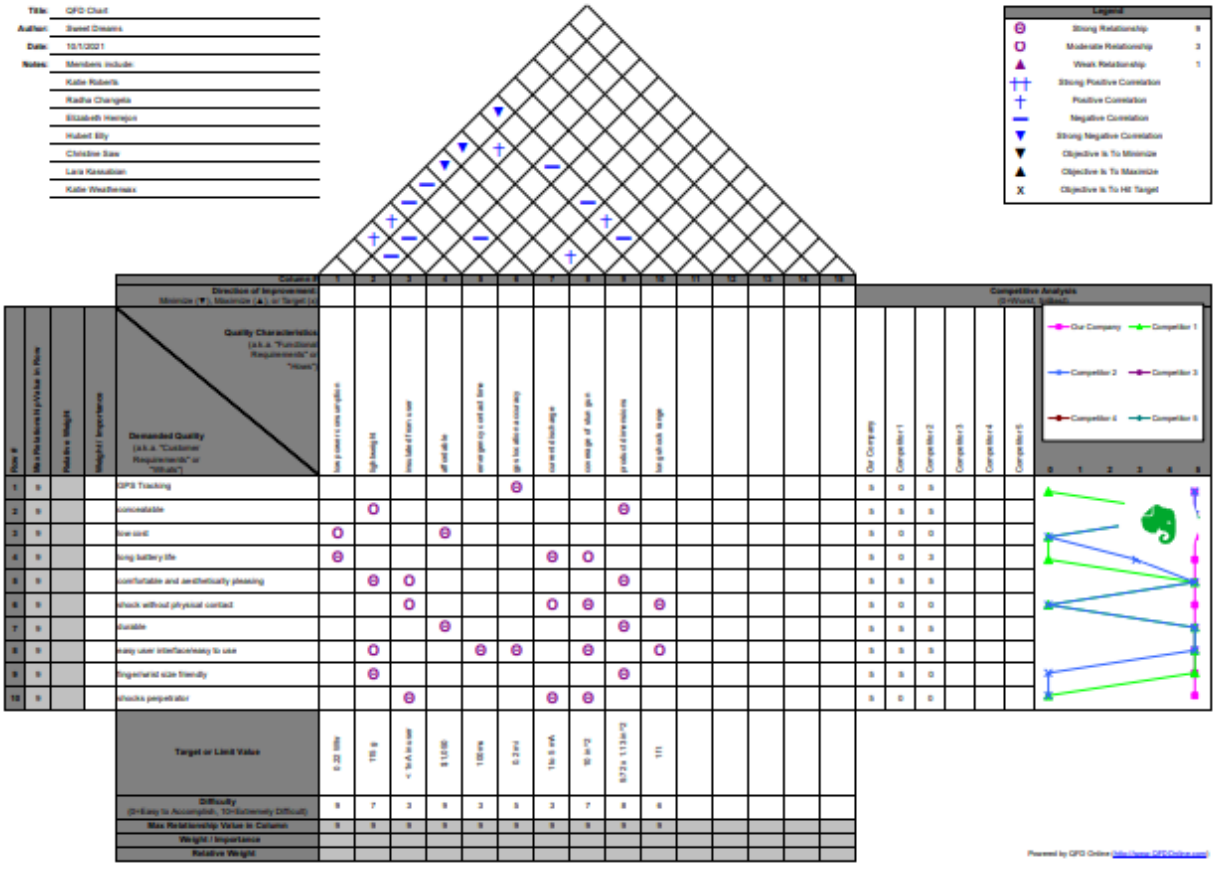

Figure 1. A QFD aligning customer requirements, design elements, and competitor analysis.

3. Technical Specifications

Table 1 contains the specific engineering requirement that will be used to determine the final product design.

Table 1. Engineering Requirements

Technical Requirement	Target/Limits	Reasoning
Low Power Consumption	0.22 Whr	Battery can last for a longer time so if the user forgets to charge it, it will still be able to protect them.
Lightweight	115 g	Not cumbersome for the user to wear so they are more likely to weir it and be protected.

Insulated from User	<1 nA in user	Insulation is important so the user will not be shocked along with the attacker.
Affordable	<$1050 to produce	The goal is to equip as many women as possible so they can be safer therefore it needs to be reasonably priced.
Emergency Contact Time	100 ms	Contacts should be notified as quickly as possible to give them more time to react and offer help to the user.
GPS Location Accuracy	0.2 mi	The more accurate the location the more likely the user's contact and the police can find her.
Current Discharge	1-3 mA	The higher the current discharge the more damage the attacker receiver and better protect the user is. However, current cannot be too high to cause permanent damage to the attacker.
Coverage of Stun Gun	10 in^2	The wider the coverage of the stun gun the more pain the attacker will feel an the less likely they are to attack again.
Product Dimension	9.72x1.13 in^2	The product dimension needs to be on the smaller size so it's not too bulky for the user to wear. Also, the smaller it is the less likely the attacker will see it as a weapon.

4. Design Approach

4.1. Design Concept Ideation, Constraints, Alternatives, and Tradeoffs

There are two main components to the device: the ring and the bracelet. The ring will hold the shocking device, having the main "gemstone" area being the contact point between the circuit and the attacker. The constraints are defined by the codes and standards as there are many when the device will be worn. The alternative devices that were researched by the team was to create a

bright “flash” device that will stun the attacker rather than shock them. Through the research, it was determined that the shocking device would be the most lightweight, and affordable solution.

4.2. **Preliminary Concept Selection and Justification – Katie R**

At the beginning of the semester many ideas were discussed for the self-defense jewelry. For example, the first design solution was to have the ring act as a chainsaw to help women break out if they were tied up. However, the technical obstacles (and the unrealistic design) were soon scrapped. The idea of a stun gun was then

Table 2. Customer Requirements

Customer Requirements	Reasoning
GPS Tracking	Allow users to ask for help when in emergency situations. This feature is currently present in similar products.
Concealable	Product should not look like a weapon so users can wear it all day without perpetrators identifying it as a weapon.
Low Cost	The goal is to equip as many women as possible so they can be safer therefore it needs to be reasonably priced.
Long Battery Life	Allows user to use product in emergency situations without worry of
Comfortable and Aesthetically Pleasing	
Durable	
Easy User Interface/Easy to Use	
Finger/Wrist Size Friendly	
Shocks Perpetrator	

4.3. **Engineering Analyses and Experiment**

Research has been done into how to complete the heart rate monitoring and the shock circuit. The heart rate circuit comes from Fitbit and open-source forums and the shock circuit comes from the prank gum. No experiments been completed at the time of this proposal to determine

the reliability of these circuits. However, as they are inspired by products it is anticipated that it will work.

4.4 **Codes and Standards**

IEEE P360 - IEEE Draft Standard for Wearable Consumer Electronic Devices - Overview and Architecture

The IEEE Standard for Wearable Consumer Electronic Devices is significant to our project as it outlines the specific technological requirements to make wearable devices secure and suitable for wear. The code affects our design as it defines technical requirements and testing methods that we will have to follow to make the device safe.

IEC 60335-2-76 Ed 2.1 Household and similar electrical appliances – Safety

The International Electrotechnical Commission (IEC) household and similar electrical appliances standard is important to our project as it sets the safety requirements for electroshock devices. This standard affects our design as it sets a limitation on the maximum rated voltage of our stun gun.

IEC 60479-1 & 2 Effects of current on human beings and livestock

The International Electrotechnical Commission (IEC) Effects of Current on Human Beings and Livestock is significant to our project as it explains the thresholds and limits of current that can pass through the human body. With these standards, it explores the safety concerns with each range of current and consequences with as mild as a tingling sensation and as severe as death. Since our jewelry has a stun gun, we will be passing a current and a large voltage into a human being and thus our electrical components must be fine-tuned to meet the standards and

not cause unnecessary harm. These standards will affect our decisions in purchasing components such as capacitors as they must have the correct voltage rating to produce the correct range of current. Measurements that will affect these decisions will be the average resistance of the human body (provided within the standards documentation) and the current range the device will operate at [5].

IEC 60601-1 Medical Design Standards for Power Supplies

IEC 60601-1 is a series of technical standards for the safety and effectiveness of medical electrical equipment [3]. It is significant to our project as it addresses the basic safety and essential performance requirements of medical electrical equipment. Our project revolves around a self-defense wearable that may collect heart rate data. The standards give us guidance on the product requirements such as isolation, creepage and insulation clearance to ensure the device is safe for the user. However, not all countries do not comply with the same requirements. For example, China and Taiwan have only adopted the 2nd edition of the standard but the United States, Canada, and Europe have already fully adopted the 4th edition requirements [3]. Therefore, when making design decisions, we must take additional consideration into our market to ease the compliance process.

UL 69 Standard for Electric-Fence Controllers

The UL 69 standard may be meant for electric-fence controllers used only for the control of animals but is still used to verify the safety for Conducted Electrical Weapons (CEW) [5]. During two IEEE conferences, papers were released detailing how the safety of certain CEWs relates to relevant standards, “Electrical safety of conducted electrical weapons relative to

requirements of relevant electrical standards" [6] and "New conducted electrical weapons: Electrical safety relative to relevant standards" [7]. Both papers consider the UL 69 standard as it covers portable electric-fence controllers with peak-discharge or sinusoidal-discharge output for battery circuits of 42.4 V or less. Our team is creating a non-lethal weapon; therefore, this standard should be used to verify the safety of our device. These standard details load requirements and a Current vs. impulse duration graph [5]; too high of a current or a long impulse can have fatal or harmful effects. This will affect our circuit design for the CEW portion of our final product so that the final device is safe to use.

5. Project Demonstration

5.1. Stun Gun Demonstration

To demonstrate the stun gun wearable jewelry two tests will be conducted. The first test will not involve any people to test all the technical requirements. The stun gun jewelry will be placed on a lab bench with the ring's electrodes connected to a digital multimeter. We then will go through the correct sequence of events to trigger the stun gun circuit. For example,

1) Press the safety button. This button triggers the software to start charging the stun gun circuit and notify the emergency contacts the user is feeling unsafe.
    a. During the demonstration, we will show the notifications sent to the emergency contacts.
2) Apply pressure to the ring (acting as if the user punches an attacker).
    a. This will trigger the stun gun circuitry releasing the charge.

With the multimeter attached to the electrodes the current/discharge will be measured and shown to be in the required range of 1 to 3 mA.

For the next test,

For the next test, two people will demonstrate the stun gun with the following procedure

1. Person A will equip the device securing the bracelet around the wrist and the ring on any finger of their chooseing. After adjusting to fit securely. They will turn the safety switch to OFF. (Note: I'm assuming we will have a safety switch)
2. *The thing we can stun* will be connected to a high-voltage measurement device.
3. Person B will wear rubber, non-conducting gloves, and hold *the thing we can stun*
4. Person A will punch *the thing we can stun* and retain contact with *the thing*

To verify the effectiveness of the stun gun, the voltage reading should be between ____ and ____ volts and the current should be between ____ and ____ amps for a power range of _____ to _____. Additionally, neither Person A nor Person B will experience pain or tingling.

5.2. GPS and Alert System Demonstration

Two people will demonstrate the GPS and alert system with the following procedure:

1. Person A will equip the device in their hand and turn the safety switch ON. Person B will hold a phone with the GPS application installed. Person B will enter their phone number into the emergency contacts. (Are we using an app or web?)
2. Person A will press the ring onto a hard surface to activate the device.

To verify the GPS, Person B will check that their device map shows the location of the user is within 20 feet of them. To verify the alert system, Person B will receive a text message alert to their phone number.

6. Schedule, Tasks, and Milestones

The Gantt chart in **Appendix A** displays the tasks that must be completed for the device to be completed. Each task has an allotted time that is estimated for completion to stay on track. Each sub team broke down the necessary steps to complete their portion of the project.

7. Marketing and Cost Analysis

7.1. Marketing Analysis

50% of women in the US feel unsafe walking alone at night and as a result 34% and 12% of women carry pepper spray and an alarm respectively [8]. Wearable and concealable self-defense devices and weapons are not a new concept in the current market for this reason. However, each option typically focuses on one district feature. The two current products on the market with the same deliverable feature as the proposed are invisaWear and Defender Ring. InvisaWear is designed as a necklace or bracelet with a button that sends your location to emergency dispatchers and users' friends and family during an emergency [9]. Defender Ring is a ring with a small hidden blade that can be used during an emergency [10]. These products lack the ability to fight off a perpetrator while notifying emergency dispatchers and friends and family.

7.2. Cost Analysis

8. Current Status

The major features and technical specifications of the device have been determined. Research into the stun gun circuitry and the GPS has already begun. Research so far has mainly been focused on miniaturizing the stun gun circuitry. The electrical components required for the device will be determined once a feasible technical design plan is formulated.

8. **Leadership Roles**

The current leadership roles of the team are:

- Webmaster: Hubert Elly
- Expo Coordinator: Katie Weatherwax
- Documentation: Radha Changela
- Electrical Lead: Katie Roberts
- Mechanical Lead: Lara Kassabian
- Software Lead: Christine Saw
- Leadership Coordinator: Elizabeth Herrejon

9. References

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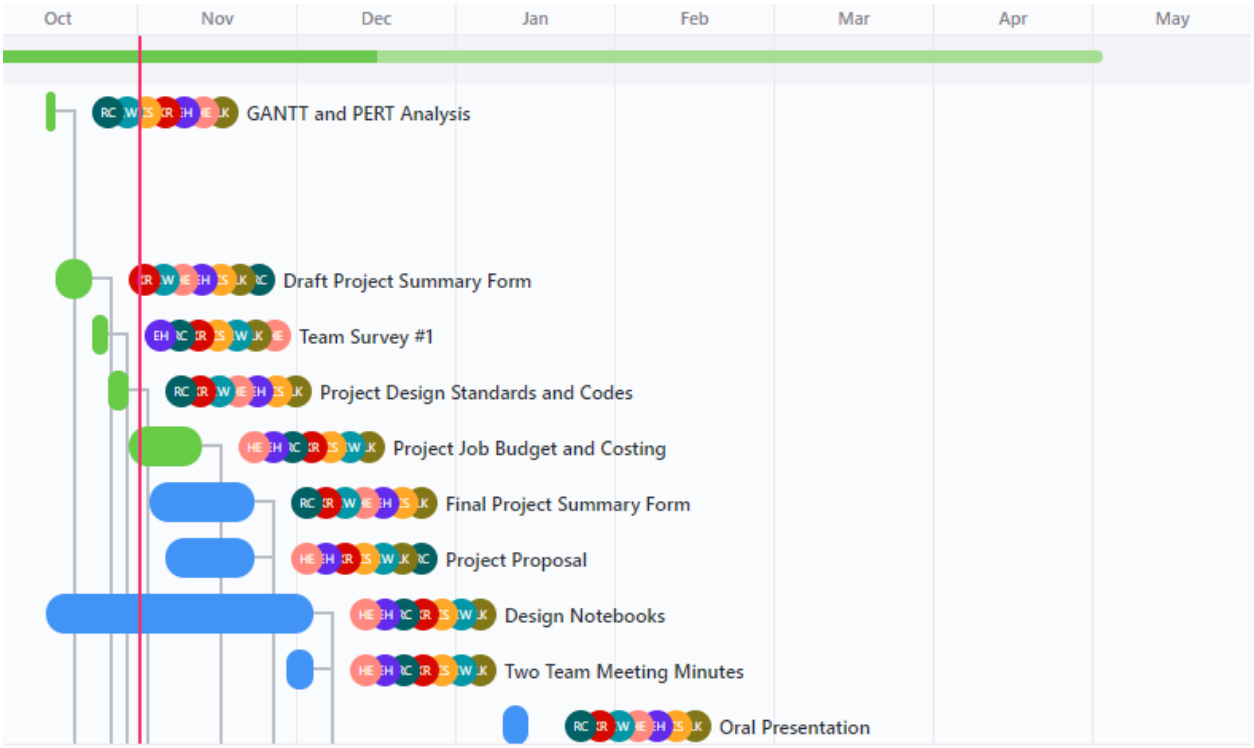
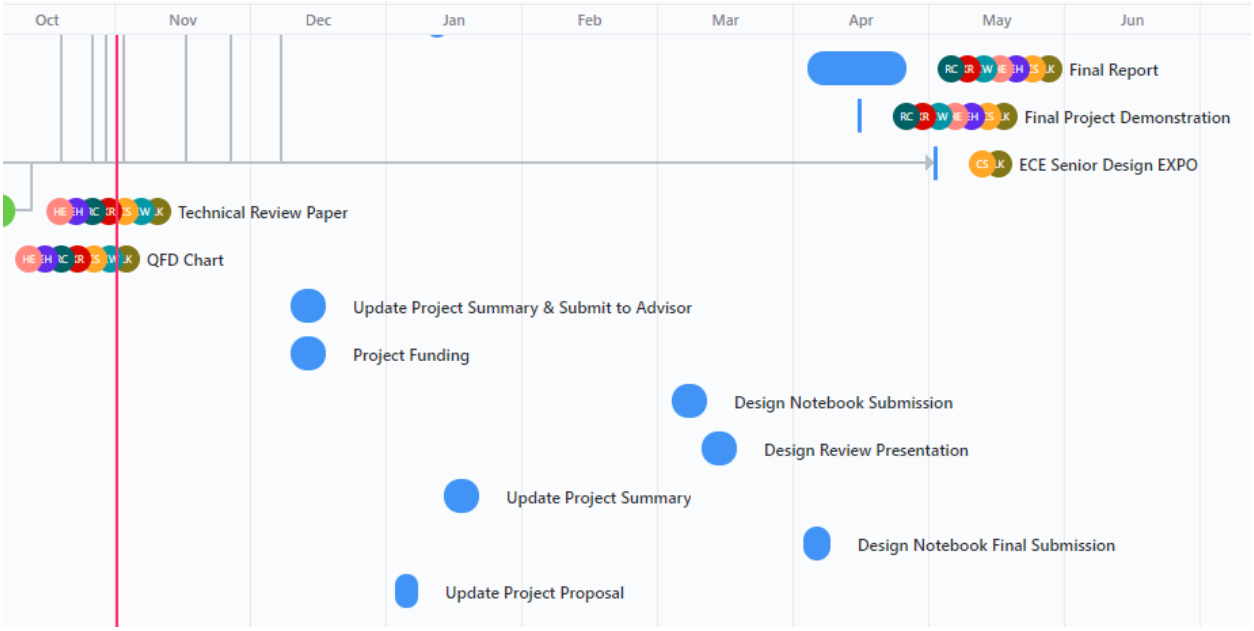
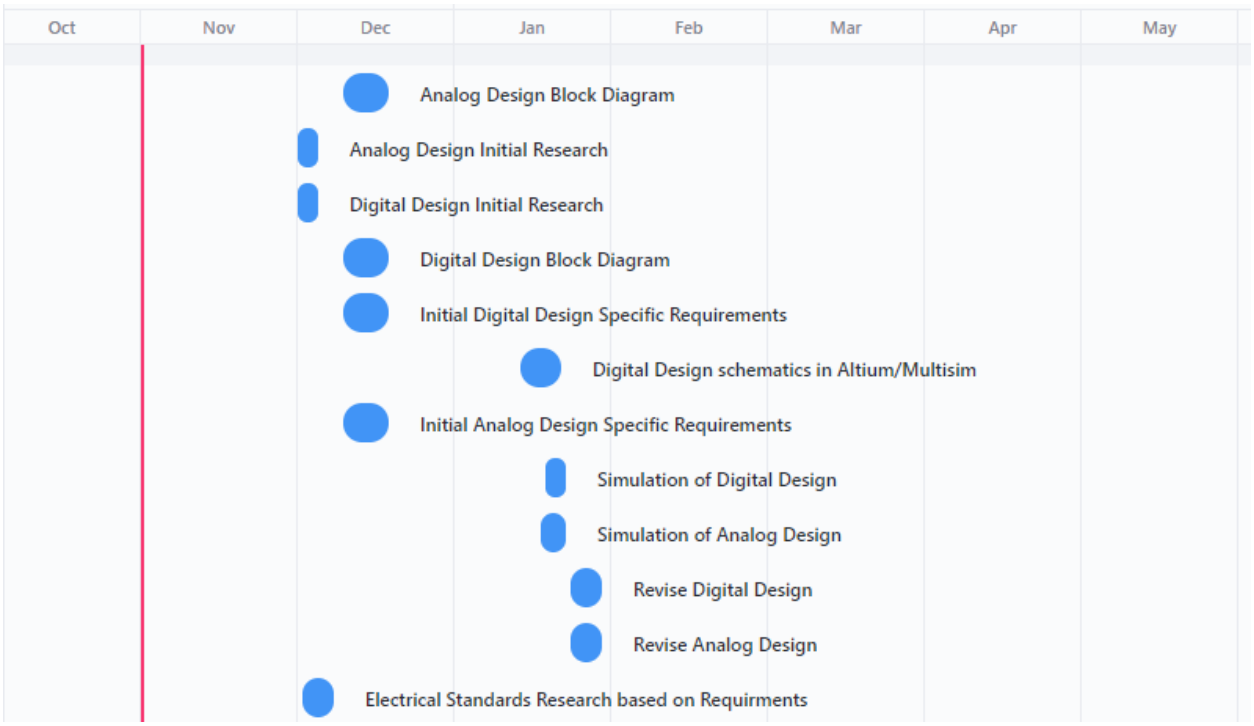
Appendix: Gantt Chart



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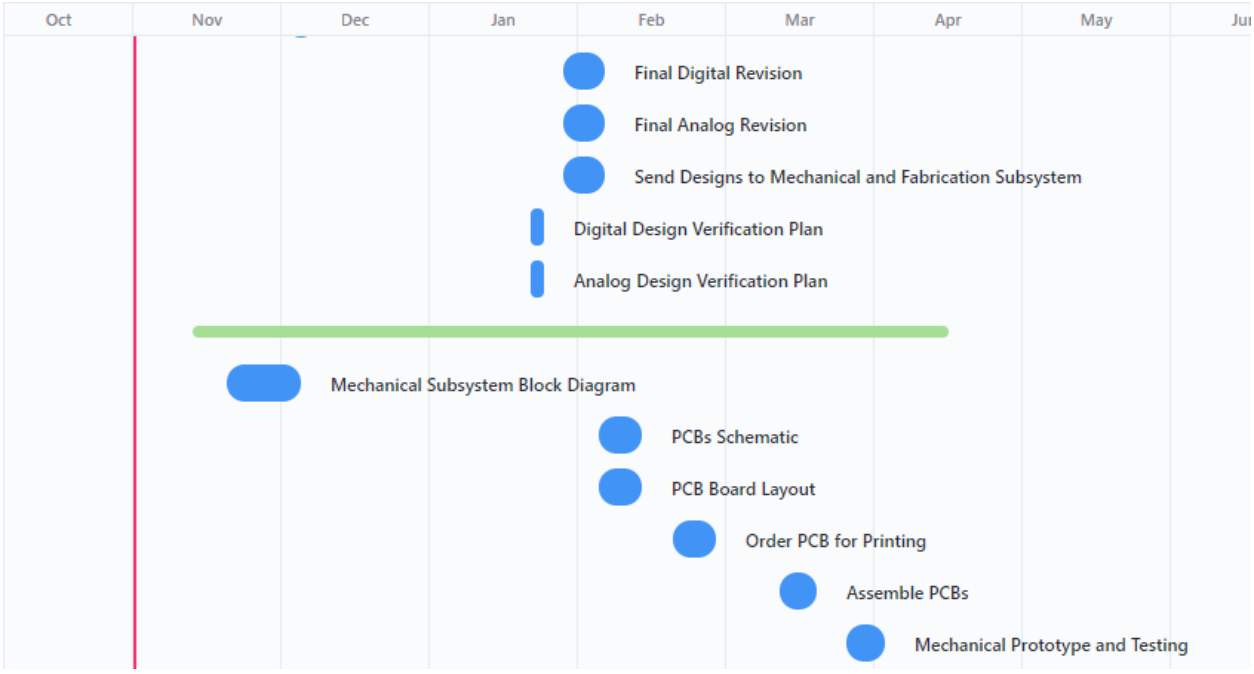
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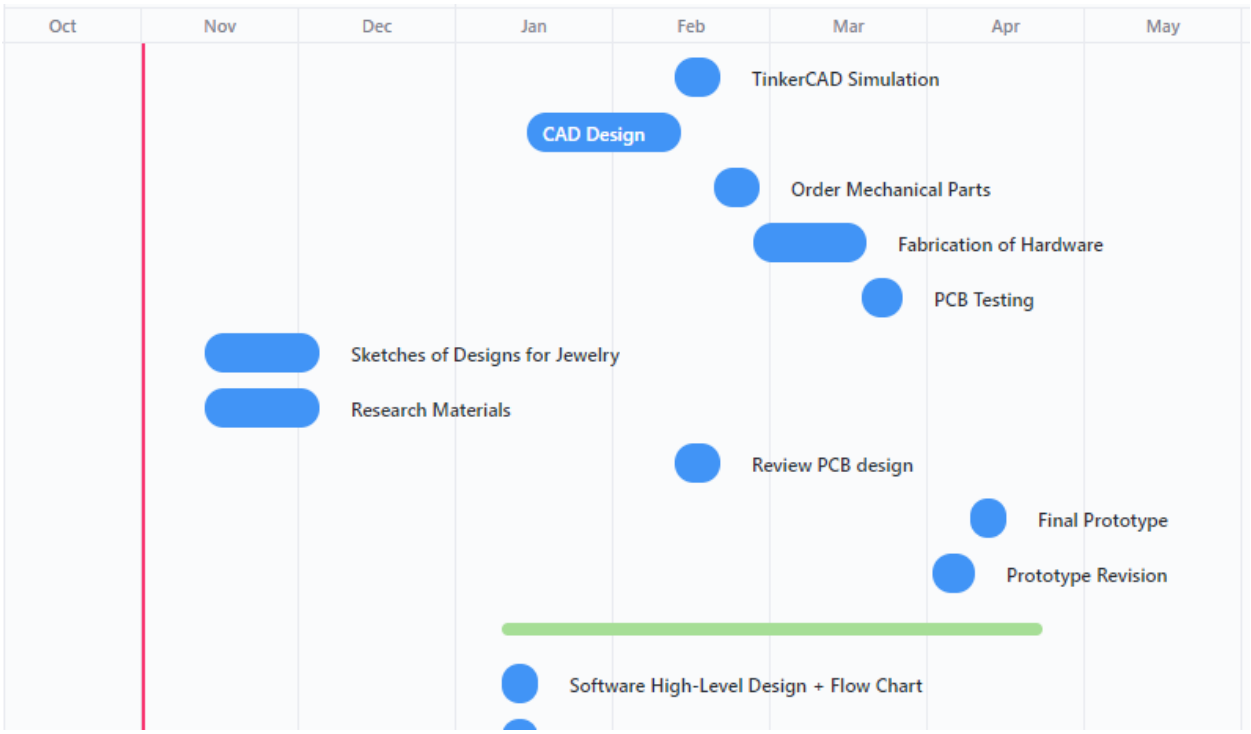
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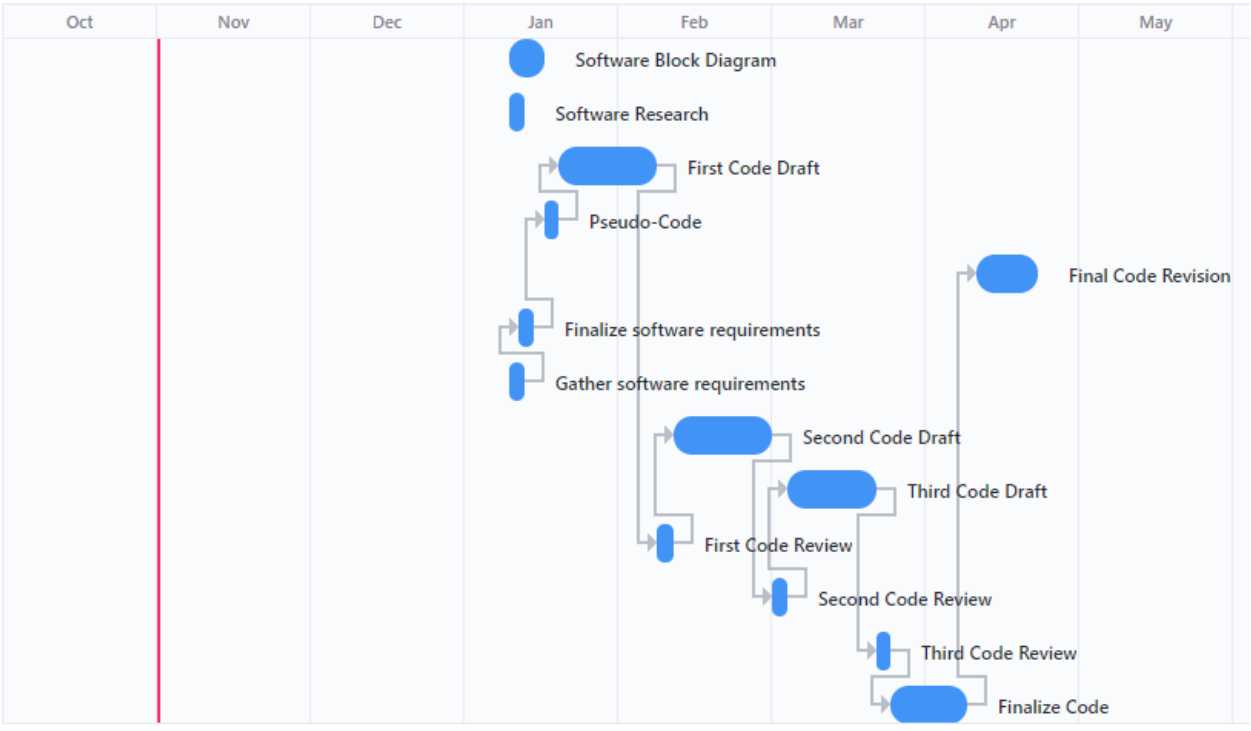
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